Some biomedical applications of *Balanites aegyptiaca* grown naturally in radioactive area, Southeastern Desert, Egypt

A.M.A. Morsy a,*, I.A. Ahmad b, A.M. Kamel c

a Nuclear Materials Authority, P.O. Box 530, El Maadi, Cairo, Egypt  
b Chemistry Department, Faculty of Science, Cairo University, Egypt  
c Labeled Compounds Department, Radioisotopes Production Division, Hot Labs Center, Atomic Energy Authority, Abou-Zaabal 13759, Egypt

**Abstract**

*Balanites aegyptiaca* is a naturally grown desert plant at some radioactive places in Wadi El-Gemal area, Southeastern Desert. The aim of the present study was to highlight on the *B. aegyptiaca* species grown naturally at radioactive places in Wadi El-Gemal area (fruit part) on the ability of using the fruit in some biomedical application (glucose, cholesterol, triglycerides, HDL-cholesterol, LDL-cholesterol and diabetes). The investigated plant was collected from different location at Wadi El-Gemal area. The uranium content was determined previously and different concentrations from the fruit with highest uranium content were used to examine the effect of *B. aegyptiaca* (fruit part) on the glucose, triglycerides, total cholesterol (HDL and LDL-cholesterol) levels using experimental rats. Different analysis techniques were used in order to determine different parameters. The obtained data suggest the beneficial role of *B. aegyptiaca* fruit as an anti-diabetic and hypo-lipidimic agent.

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## 1. Introduction

Day after day medicinal plants gain more importance due to the presence natural antioxidants believed to exert their effect by reducing the formation of the final active metabolite of the drug-induced systems or by scavenging the reactive molecular species to prevent their reaching a target site [1,2] It has been documented that several medicinal plants show their hypoglycaemic effects associated with a significant alteration in the activity of liver hexokinase [3] and glucokinase [4]. *Balanites aegyptiaca* plant is one of these types of plants used locally in the treatment of diabetes. Diabetes is a syndrome of impaired carbohydrate, fat and protein metabolism caused by either lack of insulin secretion or decreased sensitivity of the tissues to insulin. Diabetes mellitus is the most common endocrine disease worldwide. In 2002 around 173 million people suffered from diabetes mellitus. Around two thirds of these people lived in developing countries. Diabetes epidemic spreads in the developing world; the number of people with diabetes will increase by 150% in the next 20 years, with an increasing proportion of affected people in younger age groups. This multiple disorder is characterized by chronic hyperglycaemia with disturbances of carbohydrate, fat and protein metabolism resulting from absolute or relative lack of insulin secretion and insufficient cellular effect of insulin respectively. The effects of diabetes mellitus include long-term damage, dysfunction and failure of various organs [5]. In developed countries more than half of all people with diabetes are older than 65 and only 8% of adults with diabetes are younger than 44 [6]. That a reliable, cost saving therapy with traditionally used plants could be a possibility to lower the problems of untreated diabetes because of a lack of synthetic drugs. On the other side medicinal plants contain an enormous potential for the development of new drugs and the efficient treatment of diabetes. But it is necessary that their effectiveness is proved. This study deals with the effect of *B. aegyptiaca* species (that have the ability of uranium absorption) which grow naturally at some radioactive places in Wadi El-Gemal area on its efficiency in the treatment of diabetes. In other word we try to find if there was a correlation between the absorbed uranium on the plant efficiency in treatment of diabetes. Wadi El-Gemal is one of the main wadies in the Southeastern Desert of Egypt.

*B. aegyptiaca* follow the zygophile family popularly called the ‘desert date’ (Heiglige in Arabia), it is a highly drought-tolerant evergreen desert plant species. *B. aegyptiaca* is a widely distributed African plant of medicinal interest containing a number of cytotoxic and cytostatic compounds. A mixture of steroidal saponins: balanitin-6 (28%) and balanitin-7 (72%) isolated from *B. aegyptiaca*
kernels have anti-cancer activity [7]. The morphological structure of the kernel using a scanning electron microscope revealed that the protein matrix was embedded in a lake of oil droplets.

B. aegyptiaca protected the livers of treated mice against paracetamol hepatotoxicity as evidenced by a significant improvement of liver function tests. B. Aegyptiaca had a relatively modest hepato-protective activity [8]. Extracts of Balanites aegyptiaca had a moderate biological activity on major promastigotes [9]. Chapagain et al. [10] revealed that saponins from in vitro cultures of the B. aegyptiaca roots can be used as a larvicidal agent against B. aegyptiaca larvae. The analysis of total saponin content of these tested extracts and fractions revealed a strong correlation between saponin content and larval mortality [11]. B. aegyptiaca has been used as various folk medicines in Africa and Asia where the fruit is used as fumigator in liver disease in Chad [12] the bark is used in treatment of Syphilis round worm infection and as fish poison [13], the fruit and branches were lethal to snails, miracidia cercae of schistosoma [14]. Also the importance of B. aegyptiaca is back to presence of a steroidal sapogenin compound named diosgenin which is useful in pharmaceutical industries as a natural source of steroidal hormones. Studies have also revealed that diosgenin produces changes in the lipoxygenase activity of human erythroleukemia cells and is responsible for morphological and biochemical changes in megakaryocyte cells [15,16].

Morsy [17] found that B. aegyptiaca species has the ability to uptake uranium (natural source of radiation) where the concentration of uranium ranges between 0.08 and 2.35 ppm. He also found that the elevated concentration of uranium has a clear passive effect on the saponin content and precisely on the diosgenin amount (Main active constituent). Also uranium has a negative effect on the oil content, while no effect was found on the total soluble sugar amount [17].

2. Materials and methods

The investigated plant species Balanites aegyptiaca is collected from uncultivated area located at Wadi El-Gemal area southeastern Desert (characterized by the presence of uranium as a natural source of radiation) with their associated soil samples (Fig. 1) the investigated plant were identified by the authors following [18]. The uranium content was determined in the plant to insure its safety to oral intake by experimental rats for biomedical treatment of some diseases. The investigated plant samples Fig. 2 were identified by the first author. The plant samples were air dried and ground into uniform powder using milling machine. The concentration of the uranium in the investigated plant species were previously analyzed and the data was published in Morsy PhD [17], where the uranium concentration ranged between 0.08 and 2.35 ppm variable concentrations from the fruit with highest uranium content (2.35 ppm) were used to examine the effect of B. aegyptiaca (fruit part) on the glucose, triglycerides, total cholesterol (HDL and LDL-cholesterol) levels using experimental rats.

2.1. Experimental animals

In the present study 50 rats were divided into five groups, each group consisted of 10 rats. Group one was the control group that received normal diet without B. aegyptiaca, while group 2–5 received normal diet mixed with B. aegyptiaca at variable doses of 3.0 g/week/rat, 5.4 g/week/rat, 7.2 g/week/rat and 9.0 g/week/rat...
respectively (random doses). After 10 days the rats were sacrificed and the blood were collected from the hearts, then the serum were separated immediately where some biochemical parameters were measured. All animals received 100 μl of 500 mg/dl glucose intravenously 2 h before collecting the blood.

2.2. Measurement of some biochemical parameters in the serum

The biochemical parameters (glucose, total cholesterol, Triglycerides, HDL-Cholesterol) were measured in the serum of all groups using different methods [19–23]. While LDL-cholesterol was measured in the serum according to the following formula:

LDL-cholesterol = Cholesterol − Triglycerides − HDL-cholesterol

All the grouped data was statistically evaluated via the Statistical Package for Social Sciences version 7.5 (SPSS Inc, Chicago, IL, USA). Hypothesis testing methods included one way analysis of variance (ANOVA) followed by least significant differences test p-values of less than 0.05 were considered to indicate statistical significance. All the results were expressed as mean ± S.D. for ten animals in each group

3. Results and discussion

The obtained result in Table 1 and Fig. 3, indicated that the orally use of B. aegyptiaca decrease the blood glucose level, where by increasing the dose of the plant, the sugar concentration decrease and the recommended dose was that dose of G3 where at this dose the blood glucose decreased and at doses higher than the dose of G3 there is a slightly decrease in glucose concentration. This result agree with [24] who stated that some tested plants have a blood sugar lowering effect shown in animal tests, where this plant may have a moderate inhibitory effect on α-amylase activity so it can lower the blood sugar concentration. The possible mechanism of B. aegyptiaca hypoglycaemic action may be through potentiation of pancreatic secretion of insulin from β-cell of islets or due to enhanced transport of blood glucose to the peripheral tissue. 

The results obtained in Table 2 illustrated that the B. aegyptiaca had an effect on decreasing cholesterol level in the blood compared to that of the control group and the recommended dose was that dose of G3 (5.4 g/week/rat) and this dose was chosen because of the low difference between the results obtained (mean of G3 and G5), so the low dose was recommended to decrease the side effect of the drug. These results agree with Kameswara [25] who stated that B. aegyptiaca fruit part lowered blood glucose with a simultaneous decrease in triglyceride and total cholesterol blood.

**Table 1**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Groups</th>
<th>G1</th>
<th>G2</th>
<th>G3</th>
<th>G4</th>
<th>G5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glucose</td>
<td></td>
<td>158.9 ± 24.9</td>
<td>128.3 ± 13.6***</td>
<td>118.1 ± 10.2***</td>
<td>108.3 ± 13.3***</td>
<td>97.2 ± 8.1***</td>
</tr>
</tbody>
</table>

Each value is ±S.D. for 10 rats. Values not sharing superscript differ significantly at p < 0.001 for glucose.

**Table 2**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Groups</th>
<th>G1</th>
<th>G2</th>
<th>G3</th>
<th>G4</th>
<th>G5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cholesterol</td>
<td></td>
<td>131.4 ± 68.4</td>
<td>90 ± 26.5***</td>
<td>72.8 ± 22.3***</td>
<td>66.1 ± 20.3***</td>
<td>70 ± 17.7***</td>
</tr>
<tr>
<td>HDL-cholesterol</td>
<td></td>
<td>30.8 ± 9.6</td>
<td>29.2 ± 11.7NS</td>
<td>27.4 ± 8.5NS</td>
<td>26.5 ± 3.2NS</td>
<td>25.1 ± 2.6NS</td>
</tr>
<tr>
<td>LDL-cholesterol</td>
<td></td>
<td>86.2 ± 66.2</td>
<td>48 ± 31.1</td>
<td>33.3 ± 23*</td>
<td>29.6 ± 24.6*</td>
<td>38 ± 14.9</td>
</tr>
<tr>
<td>Triglycerides</td>
<td></td>
<td>72.3 ± 16.1</td>
<td>63.9 ± 23.5</td>
<td>60.2 ± 25.4</td>
<td>49.8 ± 20.8</td>
<td>34.6 ± 30.9***</td>
</tr>
</tbody>
</table>

Each value is ±S.D. for 10 rats. Values not sharing superscript differ significantly at 0.05 for triglycerides, LDL, and HDL-cholesterol while at 0.01 for total cholesterol comparing to G1.

NS = not significant.
By comparing the level of HDL-cholesterol compared to that of control group it is found that there is slightly difference between them and there is no clear effect of different dose on the level of HDL-cholesterol (Table 2). On the other hand it is found that at doses of 5.4 and 7.2 g/week/rat, there was a significant effect for B. aegyptiaca on the concentration of LDL-cholesterol (Fig. 3) These results agree with [26] who stated that B. aegyptiaca extract induced significant reduction in serum glucose, glucagons, total lipids, total cholesterol, triglycerides level and transaminases (AST, ALT and γGT) activities.

As for the concentration of triglycerides it is found that the effect of B. aegyptiaca on the of triglycerides concentration in the diabetic blood rats was found to be positive and precisely in group 5 where at the dose of 7.2 g/week/rat used the triglycerides concentration clearly decreased when compared with that of the control group.

4. Conclusion

These data show that a reliable, cost saving therapy with traditionally used plants could be a possibility to lower the problems of untreated diabetes because of a lack of synthetic drugs. On the other side medicinal plants contain an enormous potential for the development of new drugs and the efficient treatment of diabetes. But it is necessary that their effectiveness is proofed. In our study we found that although Balanites aegyptiaca grow on naturally radiated environment and the active constituent content was affected by the absorbed uranium (Morsy [17]) but it was found that B. aegyptiaca species are able to lower the blood sugar content and can be considered as high potential anti-diabetic plants which may be attributed at least in part to increased glucose metabolism and produces an increase in serum insulin (Samir et al. [26]) this mechanism belongs to first line therapies in diabetes treatment. The demonstrated results might be a base for further studies with plants. Also the plant fruit can be used for decrease the level of total cholesterol (HDL and LDL-cholesterol) and triglycerides, where the suitable dose for oral intake was 5.4 g/week/rat.

References